Atmospheric Pressure

Introduction:

Pressure is a very important atmospheric variable.
This presentation introduces Concepts of pressure,
methods for measurement, and other atmospheric variables.

The relationship between wind speed/direction and pressure is defined,
and concepts of altimetry are reviewed.

This information just begins to lay a foundation in
Understanding the fundamental atmospheric dynamics.

Atmospheric Pressure

Newton's 2nd Law of Motion

Force: A push or pull capable of changing the state of motion of an ob

(Force consists of a magnitude & direction providing another example of a vec

Equation –

$$F = m \cdot a$$

Where F = force
m = the mass of an object
a = the acceleration of the object

Units – kg m/s² or Newton (N)

Atmospheric Pressure

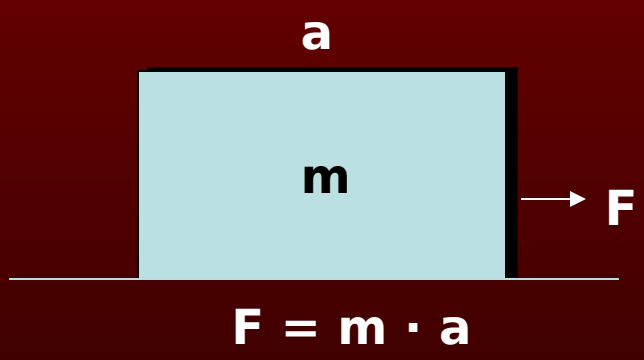
Equation: $F = m \cdot a$

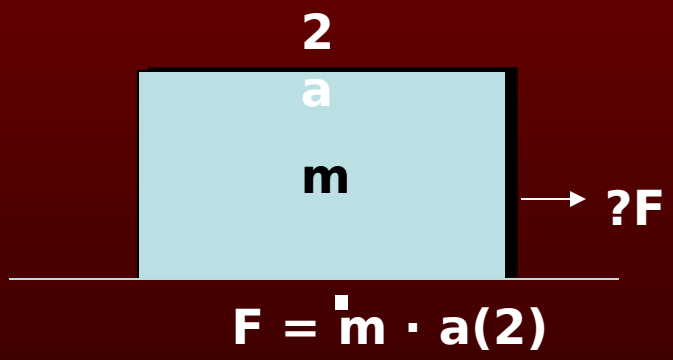
Where F = force
m = the mass of an object
a = the acceleration of the object

Variable Relationships:

- **Force is directly proportional to mass, with acceleration held con**
  $\uparrow F = \uparrow m \cdot a$
- **Force is directly proportional to acceleration, with mass held cons**
  $\uparrow F = \cdot m \uparrow \cdot a$

Example #1 – How much force must be exerted on an object of mass to double Acceleration?





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Example #2 – Which object has a greater force?

m = 2kg

a = 2 m/s²

F = m · a
F = 2kg x 2m/s²
F = 4kg m/s²

m = 6kg

a = 2 m/s²

F = (3)m ·(3)a
F = 6kg x 2m/s²
F = 12kg m/s²

Atmospheric Pressure

Weight:

- **A type of force defined using a specific acceleration due to gravity.**
- **The atmosphere exerts a force on the surface of the earth equal to its**

Equation –

$$w = m \cdot g$$

Where w = weight of the object
m = the mass of an object
g = the acceleration of the object due to gravity

Gravity always held constant at 9.8 m/s²
Units – kg m/s² or Newton (N)

<u>Variable Relationships:</u>

- Weight is directly proportional to mass, with gravity a given constant.

$w \uparrow = m \uparrow \cdot g$

Atmospheric Pressure

Atmospheric Pressure:

- **Weight of the atmosphere exerts a force over a unit area.**
- **Pressure is a scalar quantity.**

Equation –

$$P = F/A$$

Where P = pressure
F = force
A = area

Units – N/m² *or* Pa (Pascal) *or mb (millibar)*
1mb = 1hPa = 100 Pa

<u>Variable Relationships:</u>

- Pressure is directly proportional to force, with Area held constant.

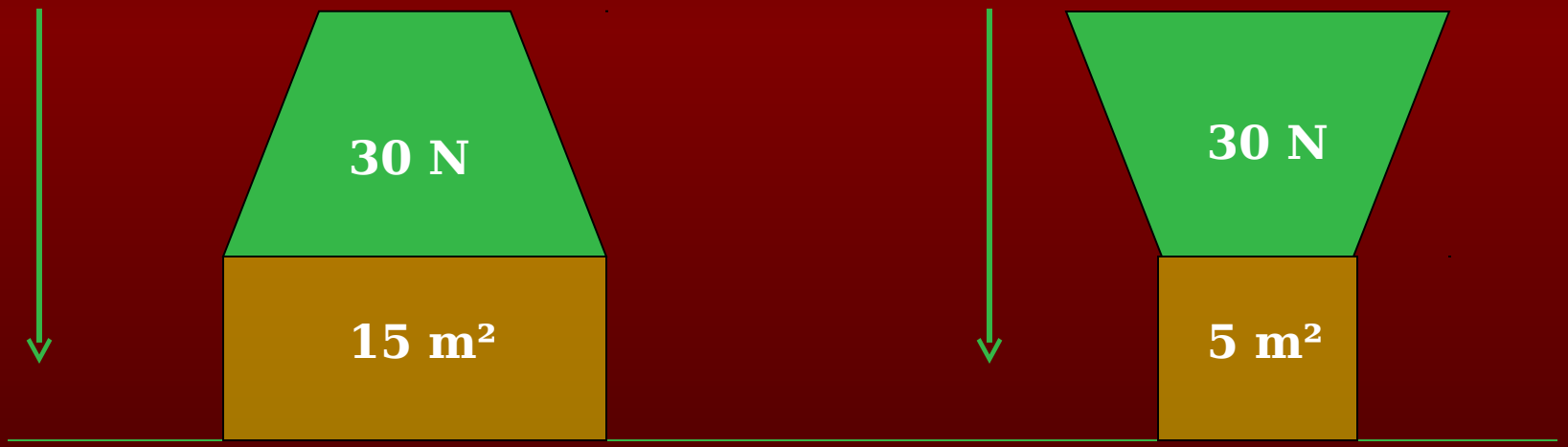
$$\uparrow P = \uparrow F \;/\; A$$

Atmospheric Pressure

Variable Relationships:

- **Pressure is indirectly proportional to Area, with Force held cons**

  ↑P = F ↓/ A



Where 30N is the force, and 15 m² or 5 m²

Atmospheric Pressure

Example #1:

$$P = F / A = w / A$$

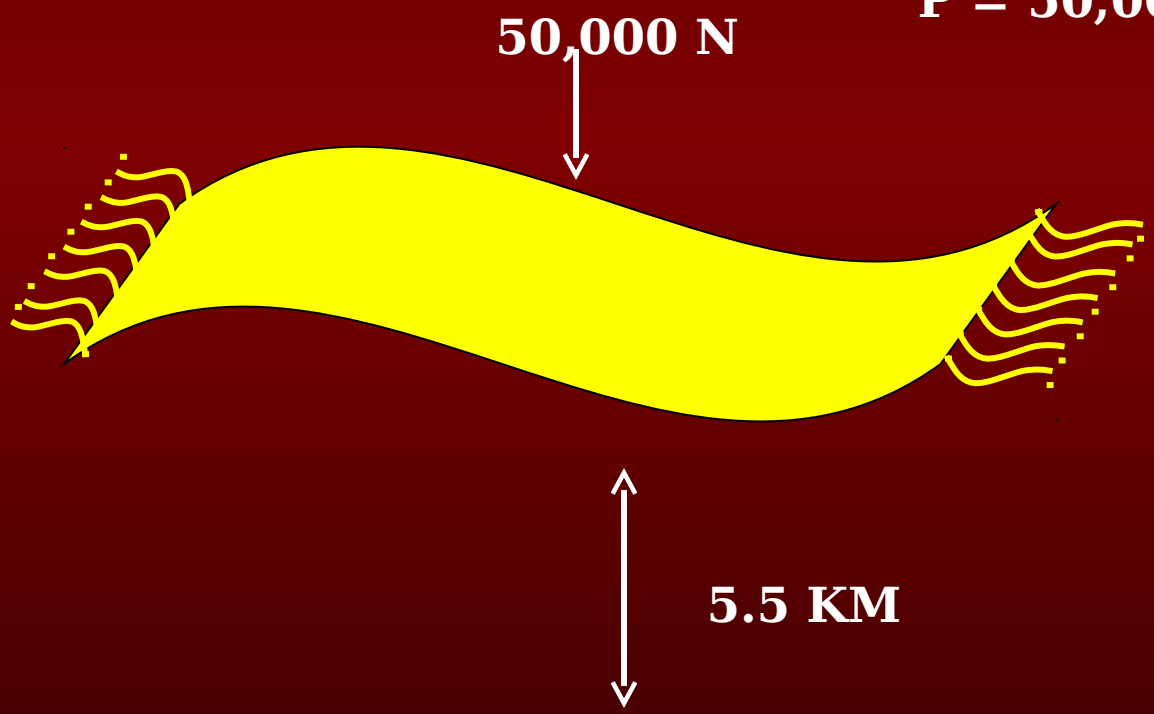
W = 50,000 N

A = 1 m²

P = 50,000 N / 1m²

P = 50,000 N

P = 50,000 PA
= 500 hPa
P = 500 mb

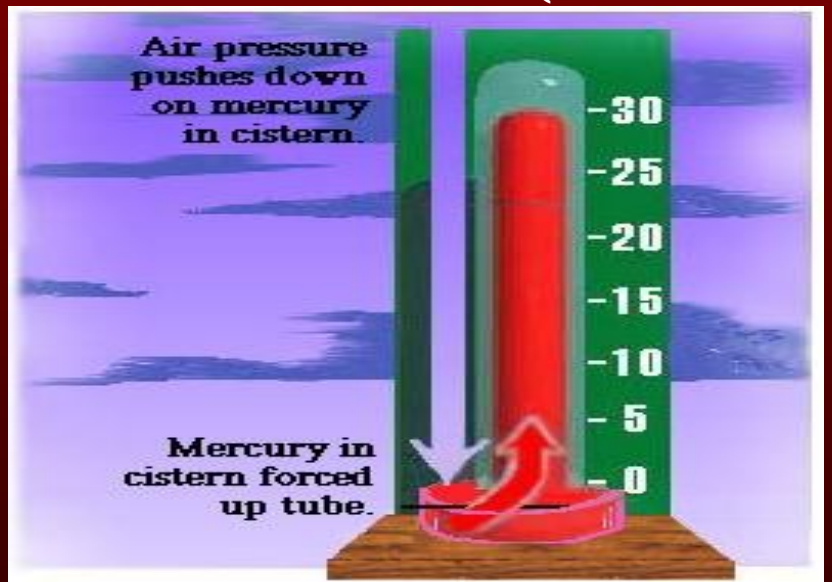


Atmospheric Pressure

Measuring Atmospheric Pressure:

Mercurial barometer -

- **Pressure is measured as a height of a Column of mercury in an evacuated Tube.**
- **An increase or decrease in pressure allows The mercury to rise or fall, respectively.**
- **Measured in millimeters or inches of Mercury, which can be converted to pressure Units.**
- **29.92 in. = 1013 mb (1 mb = .03 in)**



About the Image

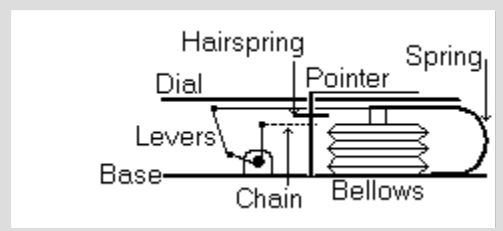
The mercurial barometer at Akureyri, Iceland is currently located inside the city Police Station where officers take pressure observations eight times a day and report them on a regular basis to the Icelandic Meteorological

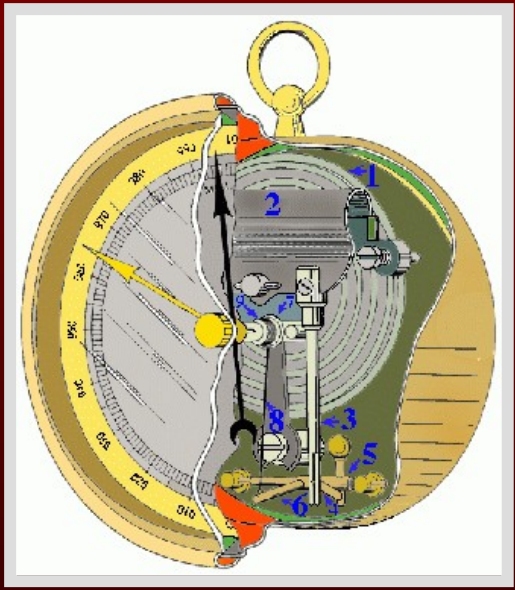
Atmospheric Pressure

Measuring Atmospheric Pressure:

Aneroid barometer -

- **Most common type, contains no fluid.**
- **Contains an aneroid cell, which is a small Flexible metal box in which the air is partiall removed.**





- **Aneroid cell is very sensitive to small changes In the air pressure. It expands and contracts as The outside pressure changes.**

Atmospheric Pressure

Measuring Atmospheric Pressure:

Digital barometer -

- **Primary pressure measuring device.**
- **Displays digital readout of station pressure**

Or the altimeter setting.

- **Pressure reported to the nearest .0001**

Inches of mercury or .1 mb.

Atmospheric Pressure

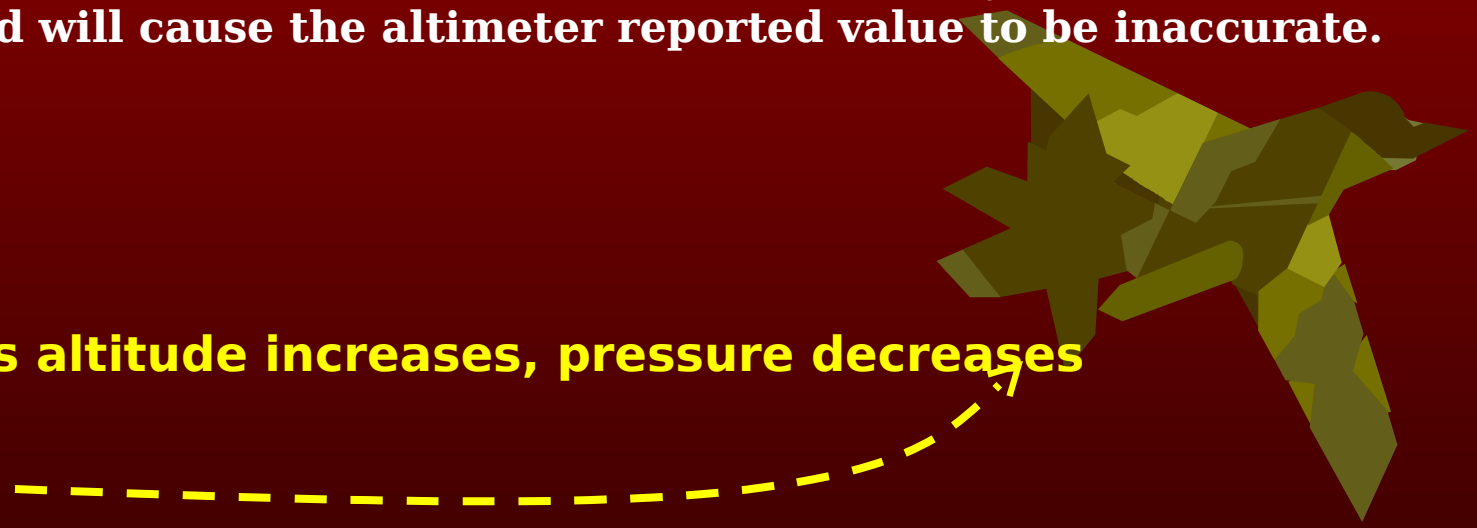
Measuring Atmospheric Pressure:

Altimeter

- **Instrument used in aircraft to determine altitude.**
- **Pressure is measured by an aneroid barometer in the altimeter, and reads Out as height above mean sea level (msl).**
- **Altitude is indirectly proportional to measured pressure.**

  As pressure decreases, altitude increases.
  As pressure increases, altitude decreases.

- **A 1,000 ft increase is approximately a 1-inch decrease in pressure.**
- **Calibrated to standard atmospheric pressure. Any deviation from Standard will cause the altimeter reported value to be inaccurate.**



Atmospheric Pressure

Measuring Atmospheric Pressure:

Altimeter Setting

- Altimeter Settings are the corrections made to altimeters to adjust for a Non-standard atmosphere .
- Since the weight and pressure over a given point varies, corrections must b Applied to the aircraft's altimeter.
- The correction is actually the altimeter setting at a local weather office Relayed to the pilot.
- QNE is always set to 29.92 inches and used by all aircraft above 18,000 feet
- QNH is corrected to the SLP of the station and used during take-off and lan And flights below 18,000 feet.
- QFE is the actual surface (station) pressure and used overseas at stations c To sea level. The altimer should read "0" when at ground level.

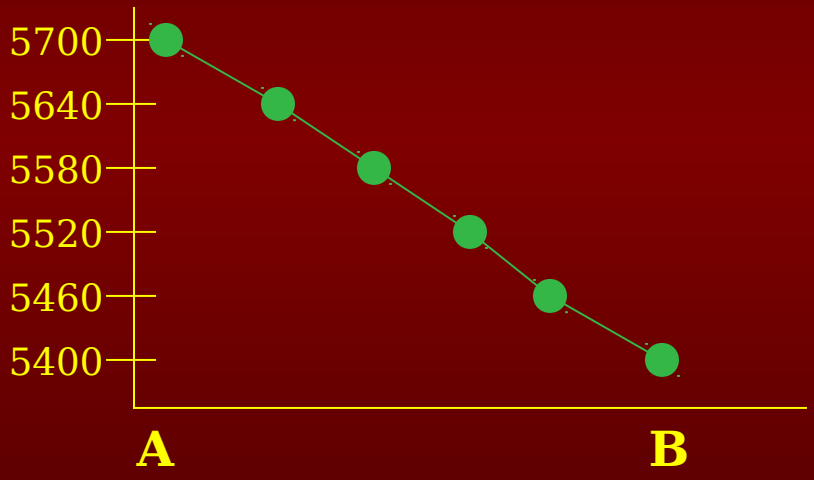
Atmospheric Pressure

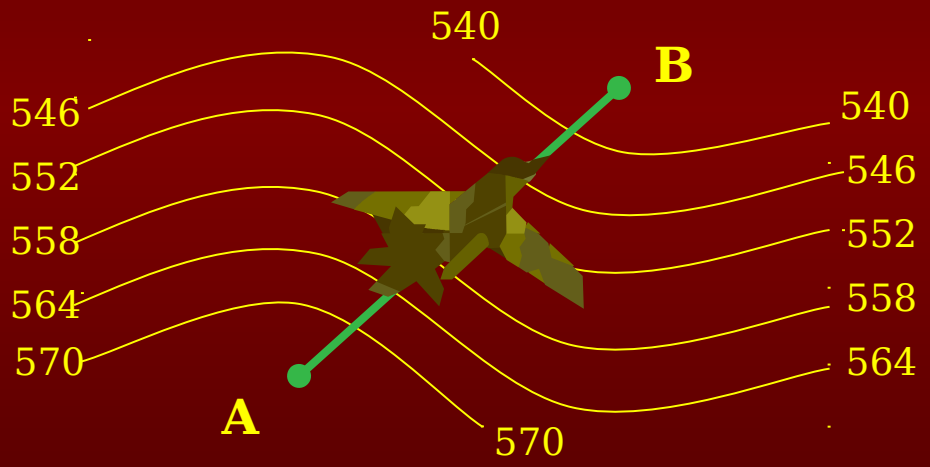
Measuring Atmospheric Pressure:

Altimetry

- **Vertical Cross Sections are useful to show the vertical path an aircraft woul**

Take if the pilot flew according to the altimeter without making any adjustme
To the altimeter setting.





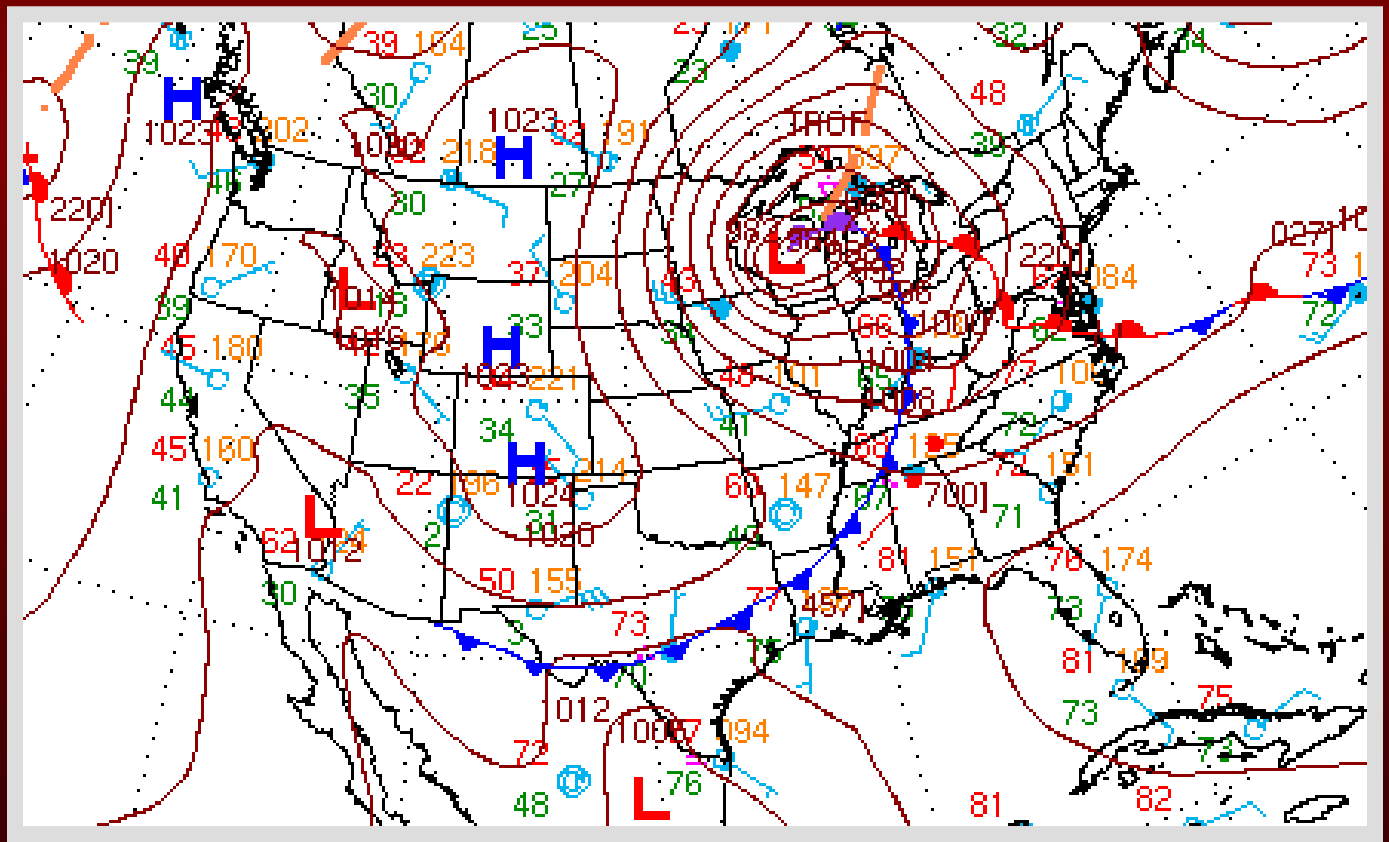
- **The altimeter is only an estimate of true altitude.**
- **Planes flying according to altimeters are flying along a constant pressure su**
- **Because heights of pressure vary, altimeters need to be corrected.**

Atmospheric Pressure

Depicting Atmospheric Pressure:

Constant Height Surfaces

- **Height everywhere on the chart is the same. Mean Sea Level.**
- **The pattern of pressure of the surface chart is depicting by connecting lines Equal pressure – Isobars. Measured every 4mb.**
- **High and Low pressure centers are marked.**



Atmospheric Pressure

Depicting Atmospheric Pressure:

Constant Pressure Surfaces

- Pressure everywhere on the chart is the same. Pressure height varies.
- The pattern of pressure of the upper-air charts is depicting by connecting l
  Equal height – Contours. Measured in decameters (Dam).
- High and Low pressure centers are marked.

Standard Dam Intervals

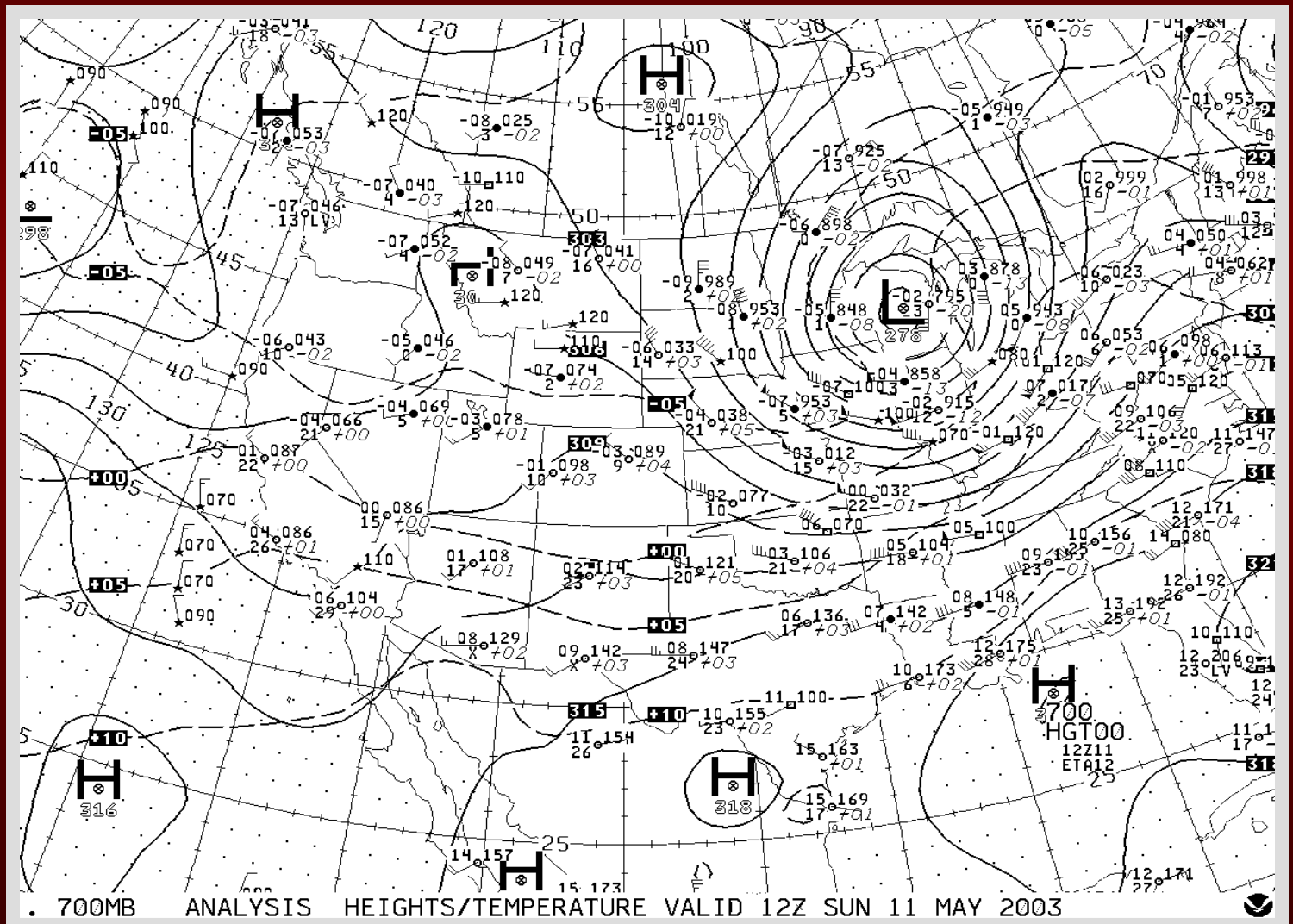
- 3 Dam – 850 & 700mb
- 6 Dam – 500mb
- 12 Dam – 300, 250 & 200 mb

	Heights	
	Feet	Meters
Surface	Field Elevation	
1000mb	364	111
850mb	4,781	1,457
700mb	9,882	3,012
500mb	18,289	5,574
300mb	30,065	9,164

Atmospheric Pressure

Depicting Atmospheric Pressure:

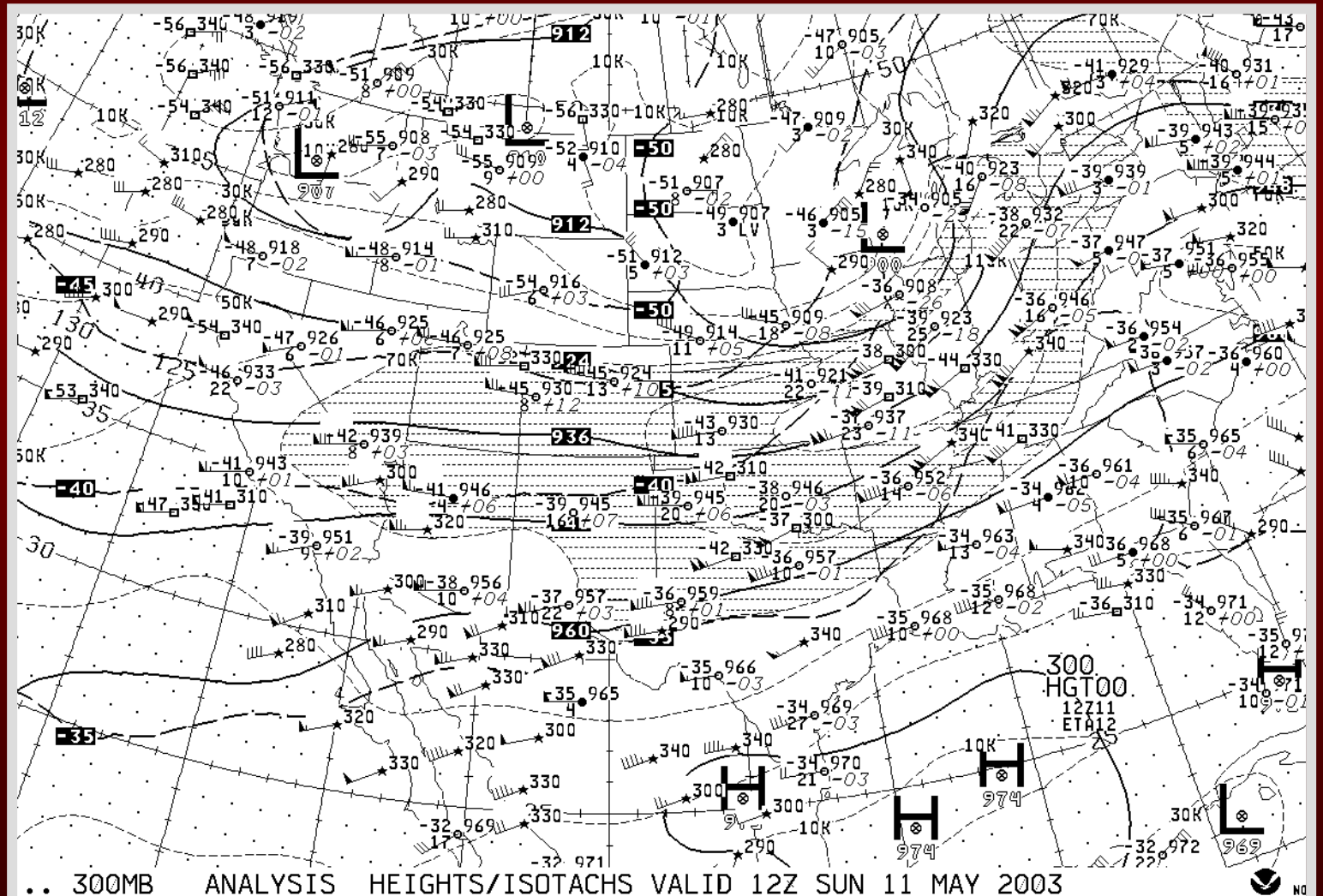
850 & 700mb Constant Pressure Charts:



Atmospheric Pressure

Depicting Atmospheric Pressure:

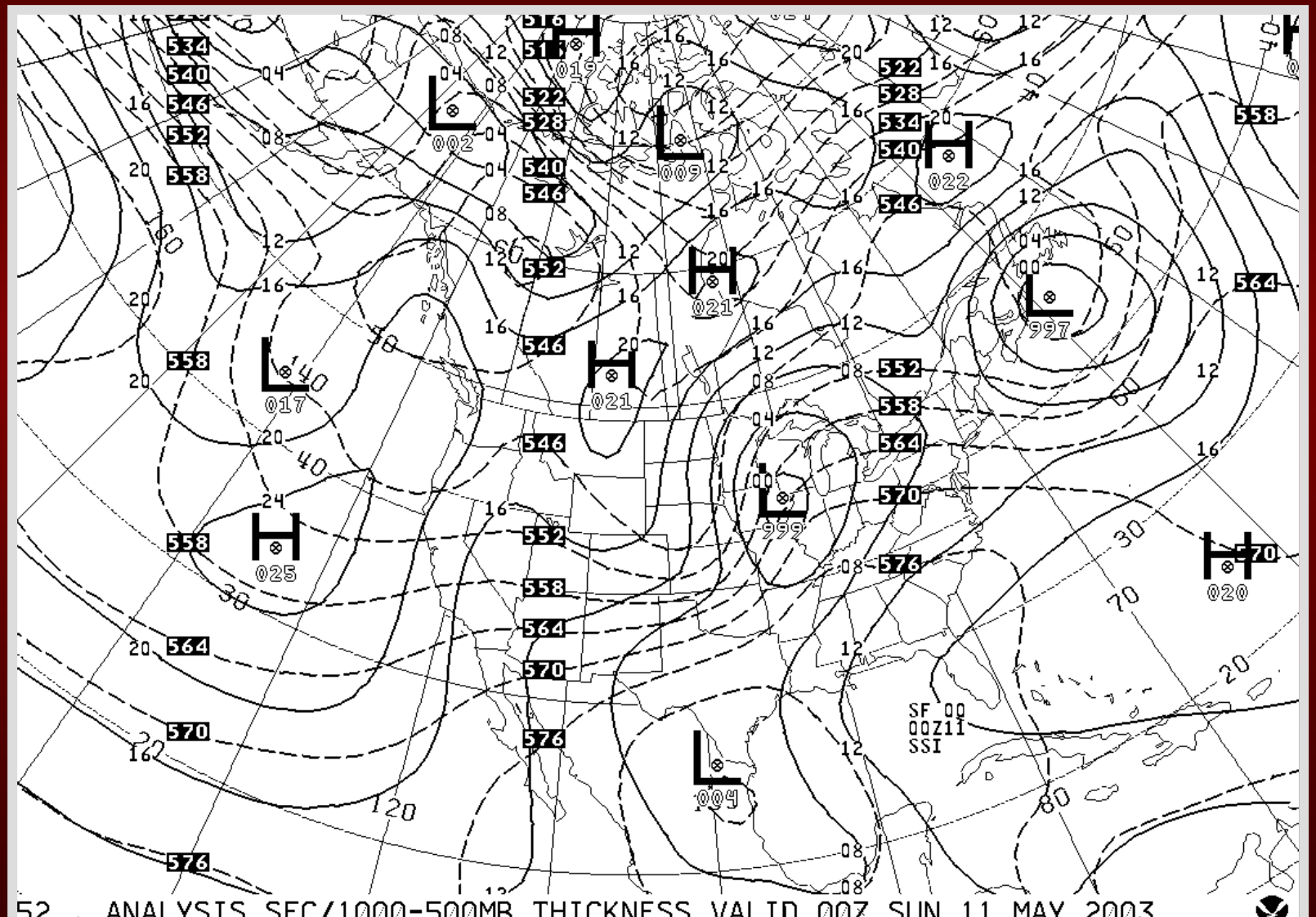
300mb Constant Pressure Chart:



Atmospheric Pressure

Depicting Atmospheric Pressure:

1000 – 500mb Thickness Chart



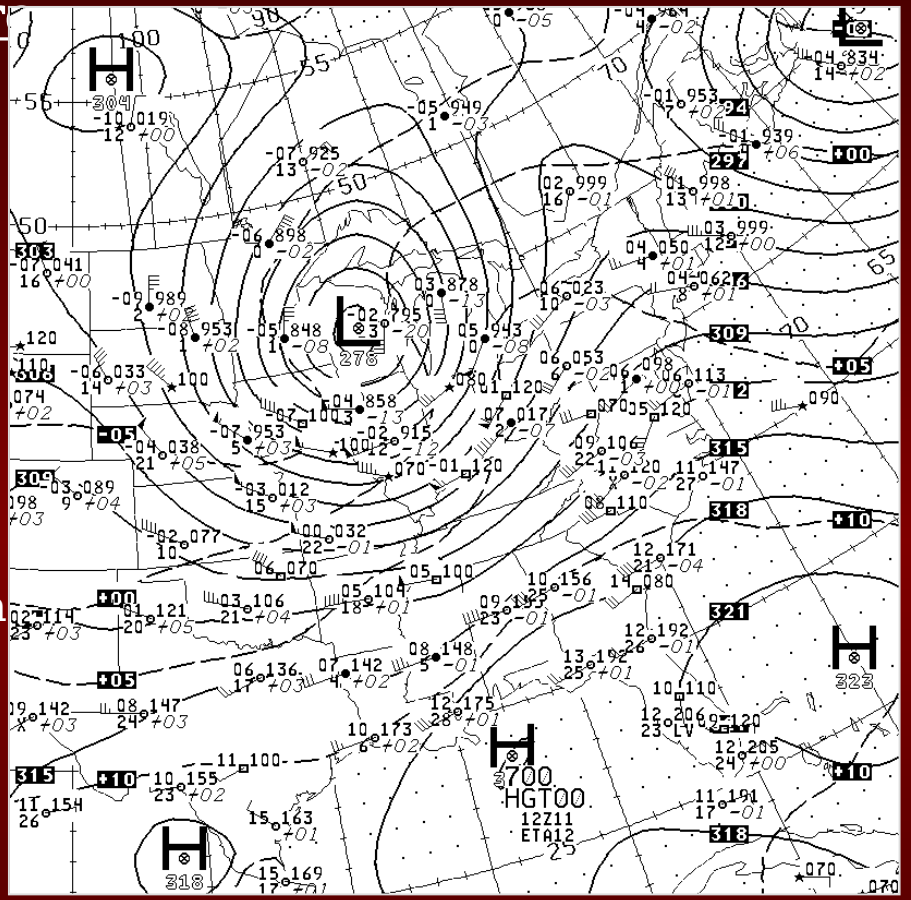
Atmospheric Pressure

Depicting Atmospheric Pressur

Features on Constant Height Charts

- Solid black lines are Contours.
- Dashed lines are Isotherms.
- Low and High centers are marked accordingly.
- Troughs and Ridges depicted by elongated areas of lower/higher heights.
- Moisture depicting by a solid circle on station plot. Dew point depression ≤5 degrees.

- Isotachs depicted as dashed and Shaded area on 300 – 200mb Charts.



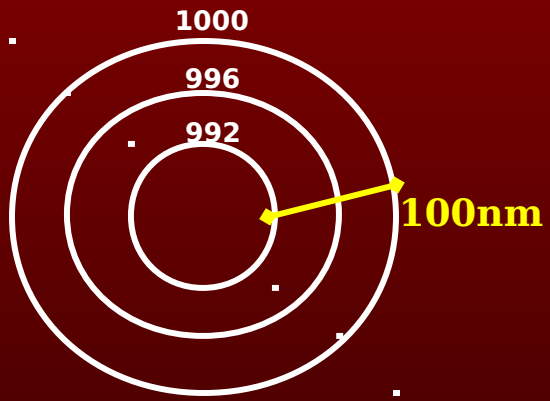
Atmospheric Pressure

Depicting Atmospheric Pressure:

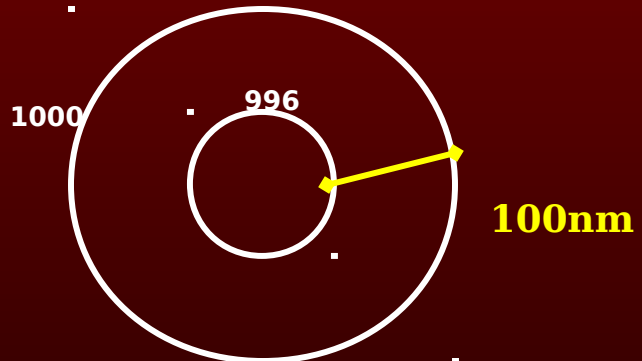
Pressure Terminology:

- **Low Pressure Center – An area of closed Cyclonic (counterclockwise) circulation.**
- **High Pressure Center – An area of closed Anticyclonic (clockwise) circulation.**
- **Gradient – Change of some quantity over a given distance.**
- **Pressure/Contour Gradient – Change of pressure per unit area.**

$$PG = \Delta P / \Delta N$$



- **Tight/Strong Gradient – The greater the pressur Change, the more closely spaced the isobars**
- **Loose/Weak Gradient – The lesser the pressure Change, the more widely spaced the isobars**



Atmospheric Pressure

Depicting Atmospheric Pressure:

Important Pressure Concepts:

- **Buys Ballots Law: With the wind at your back, low pressure will be to your left in The Northern Hemisphere.**
- **The pressure/contour gradient is directly responsible for initiating the wi**
- **Wind speed is directly proportional to pressure/contour gradients.**
- **Gradients may consist of other variables, temperature, dew points, Humidity….**

Questions

Presentation made by GySgt K.L. Hubler